

REMARKS

In response to the above-identified Office Action Applicants have amended the Title and the Specification to remedy the deficiencies pointed out by the Examiner, and have submitted herewith a separate communication providing proposed corrected drawing sheets which identify appropriate drawing figures as prior art, and which request authorization to make other drawing corrections.

Specifically, new independent Claims 19 and 25 require a solid-state image pickup apparatus having a plurality of pixels with centers of gravity of opening areas shifted outward more than the centers of gravities of corresponding converging lenses. Each of the pixels has a structure so that an optical axis of converged light passes through the center of gravity of a light-receiving surface of a photoelectric conversion element and also passes through the center of gravity of the opening area included in a light-shielding layer. This feature is supported by the descriptions at page 11, lines 19-21 and from page 12, line 22 to page 13, line 20 and Figs. 4 and 6, for example. In this context, it should be noted that the center of gravity referred to in the specification is a three dimensional point (page 11, lines 19-21), Fig.4(b) shows that an optical axis of converged light passes through an opening portion 3 and also passes through the center of disclose that pixels positioned at a peripheral position of a pixel group are arranged so that the centers of gravity of the opening areas are shifted toward the peripheral area more than the centers of gravity of the corresponding converging lenses. In addition, in the present invention, the optical axis of the converged light passes through both the center of gravity of the

light-receiving area and the center of gravity of the opening portion included in the light-shielding layer. Thus, variation of light-reception sensitivity among the pixels can be reduced (e.g., page 13, lines 8-20), even if the distance between the light-shielding layer and a light converging portion including a microlens is large and thus another light-shielding layer, such as a wiring layer, is arranged between the light-shielding layer and the light converging portion affecting incidence of the converged light onto the light-receiving area.

The above-described features of Claims 19 and 25 are not disclosed by the Yamaguchi patent. That reference discloses that in a pixel positioned in a peripheral area, the center of an opening area included in a metal layer 26 and the center of a microlens 27 are shifted toward the center of a semiconductor chip compared with the center of a photodiode 22 (e.g., Fig.2). However, the Yamaguchi patent fails to teach that the center of gravity of the opening area is shifted outward more than the center of gravity of the converging lens, and also fails to suggest the solution to the problem that a variation of the light-reception sensitivity is increased due to a large distance between the light-shielding layer and the micro lens.

Independent Claims 26 and 29 require that a solid-state image pickup apparatus of the present invention includes a plurality of image pickup areas each of which includes photoelectric conversion areas arranged two dimensionally, image pickup lenses provided to the plurality of image pickup areas respectively, and microlenses provided to the photoelectric conversion areas, respectively, and arranged between the image pickup lenses and the photoelectric conversion areas. This feature of the present invention is

supported by Fig. 13 and the description from page 18, line 2 to page 19, line 2. In addition, independent Claims 26 and 29 require that in a peripheral area of each image pickup area, positions of the microlenses and the opening portions are shifted more toward the center of each image pickup area than the corresponding photoelectric conversion areas. In independent Claims 26 and 29, the optical axis of light incident from the image pickup lenses onto the corresponding image pickup areas, respectively, are different from each other, and the shift amounts of positions must be decided in accordance with the respective optical axis. The present invention therefore shifts the positions of the microlenses and the opening portions, not toward the center of the whole of the plurality of image pickup areas, but toward the center of the corresponding image pickup area more than the corresponding photoelectric conversion areas.

Furthermore, independent Claim 29 also requires that each of the image pickup areas includes color filters of a same color so that the plurality of image pickup areas include color filters of three different colors as a whole, and the position shift amounts of the microlenses with respect to the corresponding photoelectric conversion areas differ between at least two image pickup areas including the color filters of different colors respectively. According to the present invention, differences between indexes of refraction, caused due to frequencies of the different colors, can be corrected, thereby reducing variations of output levels of the plurality of image pickup areas (see page 19, lines 3-7).

The above-described feature of the present invention recited in the independent Claims 26 and 29 is not suggested by the cited Yamaguchi patent. That reference discloses shifting of positions of opening portions and microlenses with respect to corresponding photodiodes, as described above.

Independent Claim 30 requires that a solid state image pickup apparatus of the present invention includes microlenses arranged on a layer which was evened through a CMP process, and between an image pickup lens and corresponding photoelectric conversion areas (e.g., page 19, lines 8-15). According to this feature of the present invention, a thinner evened layer can be used, thereby reducing a distance between the photoelectric conversion area and the microlens. Thus, the shift amounts of the microlenses and the opening portions with respect to the corresponding photoelectric conversion areas can be reduced since the reduced distance can result in a smaller misplacement of an optical axis of incident light. This also attains technological advantages in efforts expended in designing a layout of a sensor can be reduced.

The Yamaguchi patent also fails to suggest both the microlenses recited in the Independent Claim 30 and the technological advantages of the present invention, as described above.

Independent Claim 32 requires that a solidstate image pickup apparatus of the present invention includes an image pickup area which includes a

plurality of divided areas each including microlenses, and provides different pitches to microlenses for every divided area, so that as a whole, in a peripheral area of the image pickup area, positions of the microlenses and the opening portions are shifted toward the center of the image pickup area more than corresponding photoelectric conversion areas (e.g., Fig. 17 and page 20, lines 8-21). According to this feature of the present invention, both the reduction of a variation of output levels of a sensor and the reduction of efforts in designing a sensor layout can be attained. The cited Yamaguchi patent fails to disclose the provision of different pitches of microlenses to different divided areas of an image pickup area.

For these reasons, the present invention as set forth in Claims 19, 25, 26, 29, 30 and 32 are patentably distinct over the cited Yamaguchi patent. Also, it is noted that the other cited references, Sayuk and Martin, fail to teach a pixel, which comprises a microlens, a light-shielding layer including an opening portion, and a photoelectric conversion area, and therefore do not teach a relationship of a position shift amount of those elements among the pixels arranged two dimensionally in an image pickup area.

Also submitted with this Amendment is an Information Disclosure Statement citing certain Japanese references. Applicants submit that the newly submitted claims are also patentable over the disclosures of those documents for the following reasons.

JP-A-06-140609

This document discloses a solid-state image pickup apparatus which is arranged so that in a peripheral area of an image portion, positions of light-converging portions are shifted more in a horizontal direction with respect to light-receiving portions, and positions of intermediate layers (e.g., color filter and black-dyeing layer) are also shifted with respect to the light-receiving portions by an amount less than that of the light-converging portions. However, this reference fails to teach that a point at which an optical axis of converged light passes through an opening area, and a center of gravity of an opening area included in a light-shielding layer are concentric with each other.

JP-A-07-240877

This document discloses a solid-state image pickup apparatus which is arranged so that a plane including a photoelectric conversion element is inclined by a predetermined angle with respect to a plane which is perpendicular to an optical axis of an optical lens, and a plurality of photo detectors are arranged on the plane including the photoelectric conversion element, along a curved line. However, this document as well as the document (06-140609) fails to teach that the point at which the optical axis of converged light passes through an opening area, and the center of

gravity of the opening area included in the light-shielding layer are concentric with each other.

JP-A-06-062322

This reference discloses an image pickup element including an image pickup lens and a frame memory but is silent on a converging portion arranged in each pixel portion. The reference therefore also fails to teach the above-described relationship between the optical axis of the converged light and the center of gravity of the opening area included in the light-shielding layer.

JP-A-08-116041

This document discloses a solid-state image pickup apparatus in which microlenses are divided into a plurality of blocks, and positions of the microlenses are shifted toward a center portion with respect to corresponding photoelectric conversion elements on the divided block basis.

JP-A-08-107194

This document discloses a solid-state image pickup apparatus in which in a peripheral area of an image pickup area including pixels, positions of

microlenses are shifted toward a center portion more than corresponding opening areas.

JP-A-06-340612

This document discloses an image pickup system which includes an image sensor whose pixels are arranged so that a width of each opening area and a curvature of each microlens are changed in accordance with a pixel position. This system further includes a lens which is provided with an iris and focuses an object image onto the image sensor, a pre-signal processing circuit of a signal from the image sensor, an A/D converter, circuits for correcting a digital signal from the A/D converter, and the like.

JP-A-2001-237404

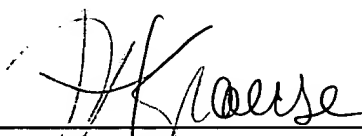
This document discloses a solid-state image pickup apparatus which is arranged so that a difference between a center of an opening portion formed in an upper-most lightshielding layer and a center of a corresponding light-receiving portion increases in a direction from a center portion of an image pickup area to a peripheral portion thereof, and a difference between a center of a microlens and the center of the corresponding light-receiving portion is larger than the difference between the center of the opening portion included in the upper-most light-shielding

layer and the center of the corresponding light-receiving portion.

For all these various reasons Applicants solicit the issuance of a formal Notice of Allowance in this application.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address given below.

Respectfully submitted,

A handwritten signature in dark ink, appearing to read "J. A. Krause", written over a horizontal line.

John A. Krause

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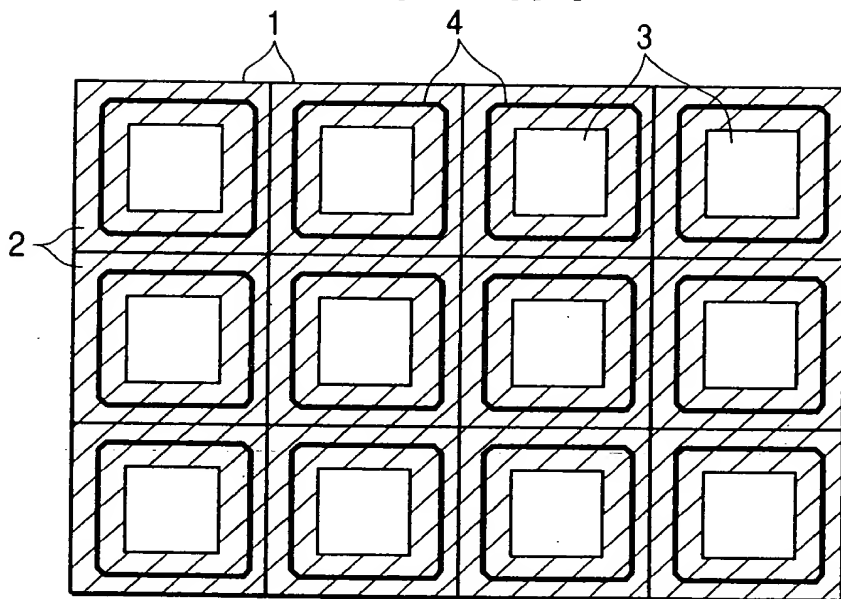
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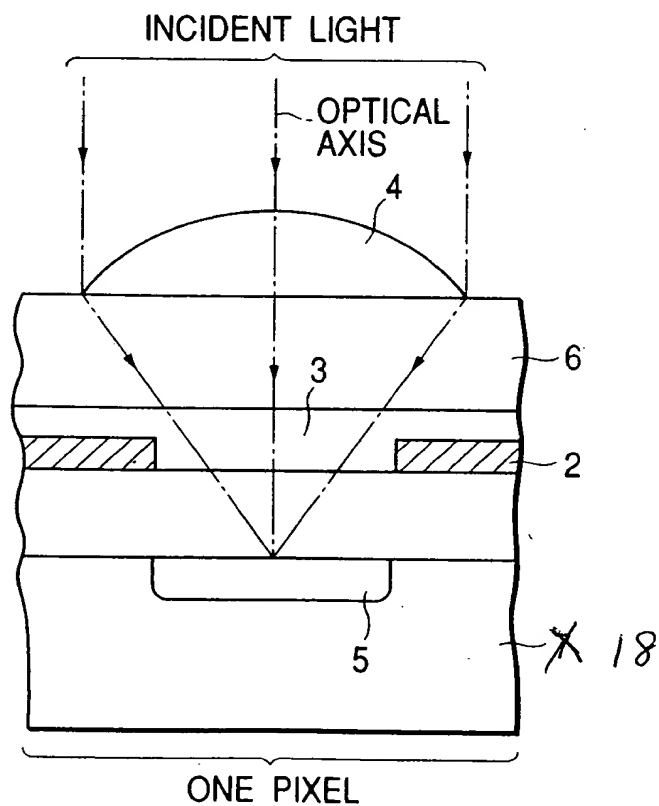
PRIOR ART

FIG. 1A



PRIOR ART

FIG. 1B





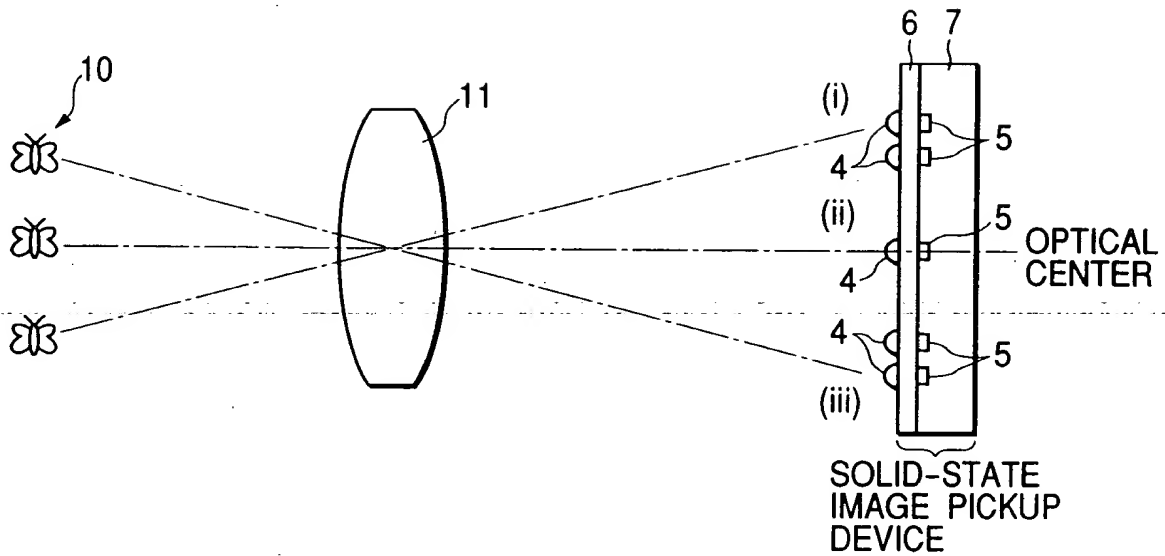
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PRIOR ART
FIG. 2A



PRIOR ART
FIG. 2B

